Monitoring the Spread of Invasive Grasses in South Dakota Using NASA Earth Observations and NOAA Climate Data Records

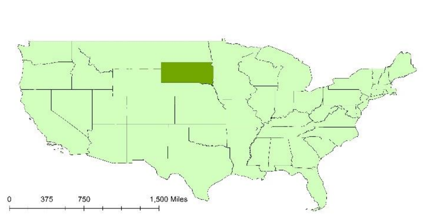
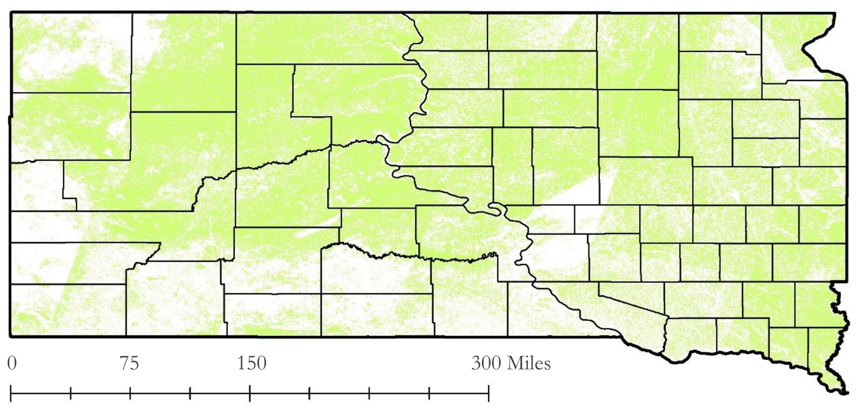
Abstract

Invasive grass species, specifically *B. tectorum* (cheatgrass), *B. japonicus* (japanese brome), and *Melilotus* (sweet clover), have expanded out of the Great Basin and into the western Great Plains of the United States. Increased development and land use in western South Dakota have provided a gateway for these species to invade and dominate formerly native grasslands. This project evaluated the historic distribution of invasive species, by creating invasive species distribution maps on a county level of South Dakota for 1997-2018. Landsat 5 Thematic Mapper (TM) and Landsat 8 Operational Land Imager (OLI) were used to classify regions of grassland and non-grassland in South Dakota. Invasive and native grasses were identified within the grassland regions using Earth Observations and phenological climate data records. Phenology variables from the NOAA Advanced Very High-Resolution Radiometer (AVHRR) climate data record included Normalized Difference Vegetation Index (NDVI), Leaf Area Index (LAI), and Fraction of Absorbed Photosynthetically Active Radiation (FAPAR). Forwarn Phenology Parameter Products derived from MODIS also provided additional NDVI data. These phenology variables from AVHRR and Forwarn were studied to determine a method to distinguish between native and invasive grasses. The team validated the classification of native and invasive grasses using *in situ* data to cross reference and compare to the remote sensed data. This comparison also provided insight into the spatial and temporal completeness of the *in situ* data reporting in the area. Finally, the team used regression modeling to make future projections of land cover classification by county. The methods applied to our case study region of South Dakota will serve as a guide for historical and future invasive grass identification over the Great Plains region. The results will be used to inform local management practices and combat ecosystem threats, such as an increased risk of wildfire and an altered biomass of the region that impact cattle grazing patterns.

Objectives

- **Identify** regions of invasive and native grasses in South Dakota from 1997 to 2018 using Earth observations and Climate Data Records
- **Map** the percentage of invasive grass area per total area of grassland in South Dakota on the county level
- **Predict** future invasive grass distribution in South Dakota on the county level using the slope derived from a regression model

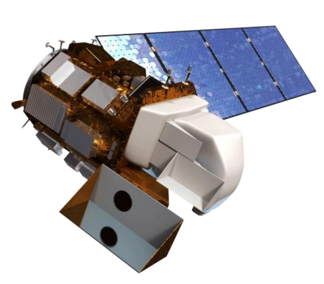
Study Area

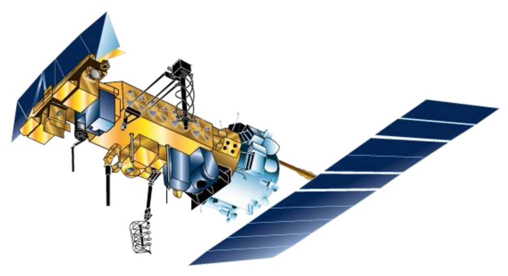
Earth Observations

Landsat 5 TM

Landsat 8 OLI



AVHRR



Team Members

Brooke Adams
Project Lead

Conor Mulderrig

Forest Cook

Project Partners

- **DOI**, National Invasive Species Council Secretariat
- **NOAA** Central Region Climate Services, Central Region
- **USDA**, Agricultural Research Service, High Plains Grasslands Research Station

Methodology

Estimate Phenology
- Define characteristic values for invasive and native grass
- 20% values and day of year of AVHRR NDVI, LAI, and FAPAR

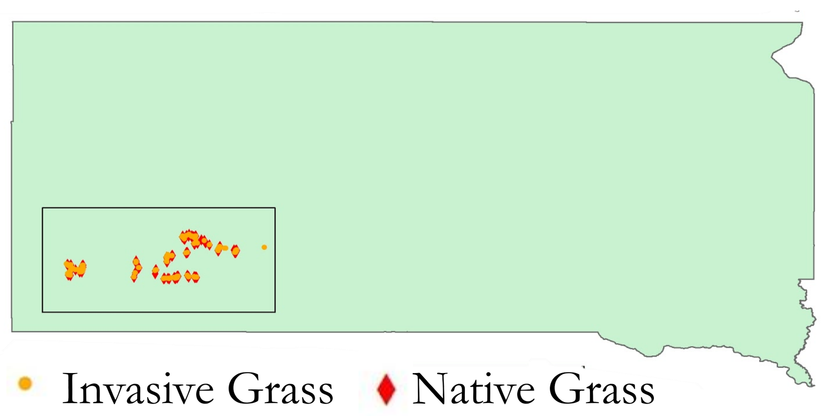
Identify Regions of Invasive Growth
- Identify regions of native and invasive grasses
- Verify results using *in situ* data

Quantify Invasive Grass Presence
- Calculate the percentage of invasive grass to native grass area by county for 1997- 2018

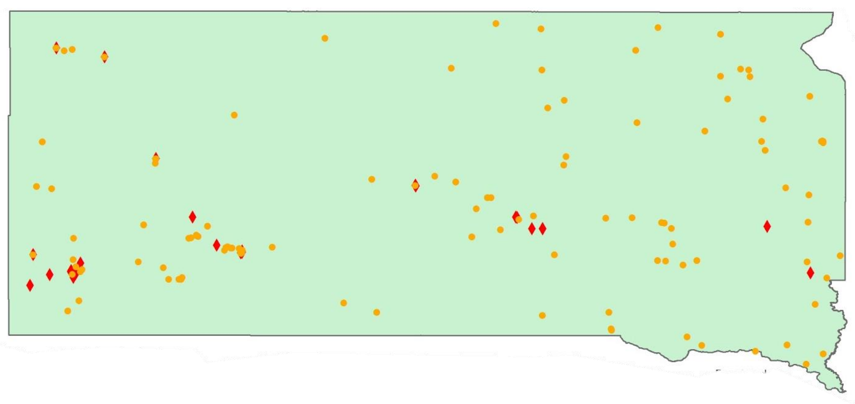
Forecast Growth
- Predict the distribution of invasive grasses through 2022 via regression modeling

Results

1997 Native & Invasive Field Points



1998-2016 Native & Invasive Field Points



• Invasive Grass ♦ Native Grass

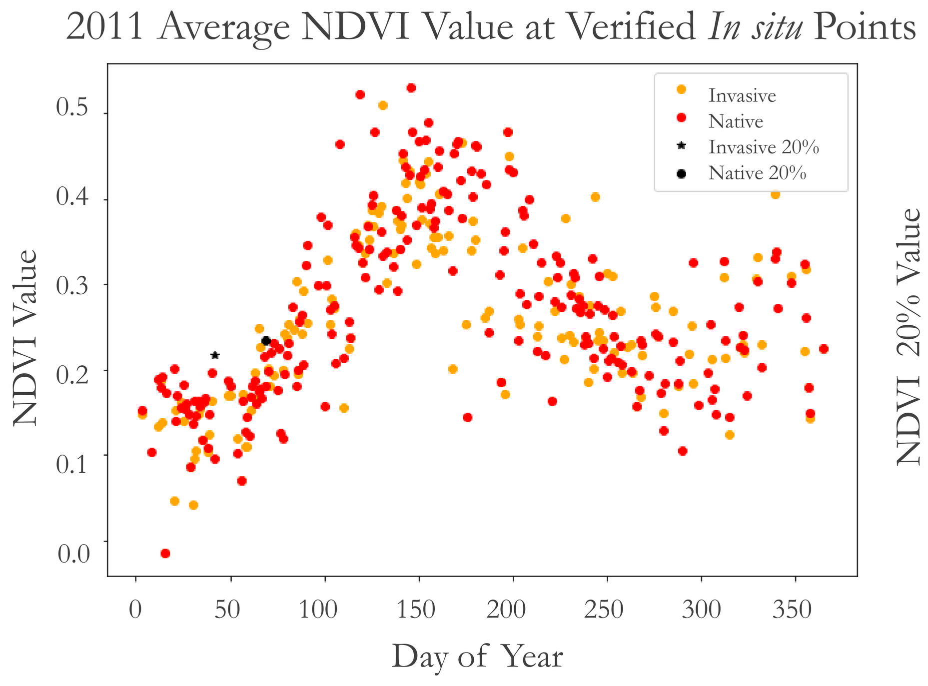
***In situ* Point Data to AVHRR 0.5° x 0.5° Gridded Data:**

Total Invasive points	370
Unique Invasive (1 / pixel)	189
Mixed Pixels	84
Total Unique Invasive	105

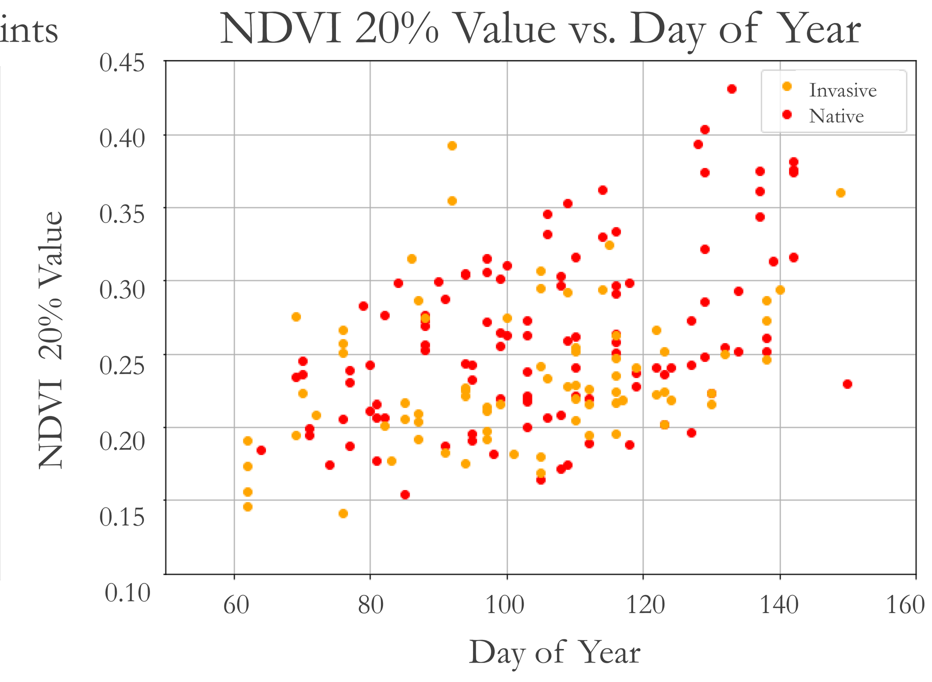
Total Native points	677
Unique Native (1/ pixel)	275
Mixed Pixels	84
Total Unique Native	191

Example Analysis of AVHRR NDVI, LAI, FAPAR:

2011 Average NDVI Value at Verified *In situ* Points



NDVI 20% Value vs. Day of Year



Conclusions

- AVHRR NDVI, LAI, and FAPAR data can act as proxies for native and invasive grass presence in South Dakota.
- The *in situ* data used for ground truth were identified as a limiting factor in the remote sensing of invasive grasses in terms of:
  - Spatial and temporal resolution- ~28% of the total *in situ* data points for invasive and native grasses were unique
  - *In situ* points were taken in pixels with heterogeneous land cover (bare rock or on the edge of a body of water)
  - Lack of metadata surrounding the data collection
- Our partners can improve the feasibility of similar remote sensing projects by using these results to inform their field data collection process.

Acknowledgements

We would like to thank our Center Lead: **Aaron Mackey**, Assistant Center Lead: **Andrew Shannon** and our Science Advisor **Jessica Matthews** for their guidance and insight

We would also like to acknowledge:

- **Bill Christie:** Southern Research Station: USDA Forest Service
- National Centers for Environmental Information (NCEI) Employees
- NASA DEVELOP National Program Office

South Dakota Ecological Forecasting | North Carolina – NCEI | Summer 2018